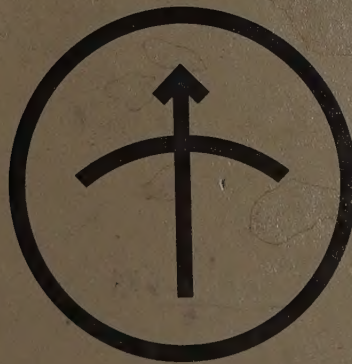


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MODEL 95
STANDARD SIGNAL GENERATOR

Operating
INSTRUCTIONS

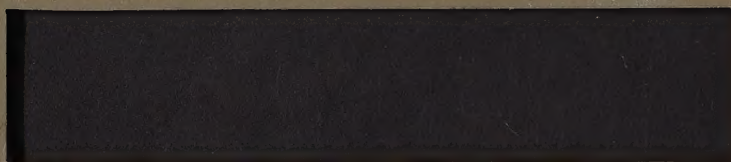


MEASUREMENTS

A MCGRAW-EDISON DIVISION

BOONTON

NEW JERSEY



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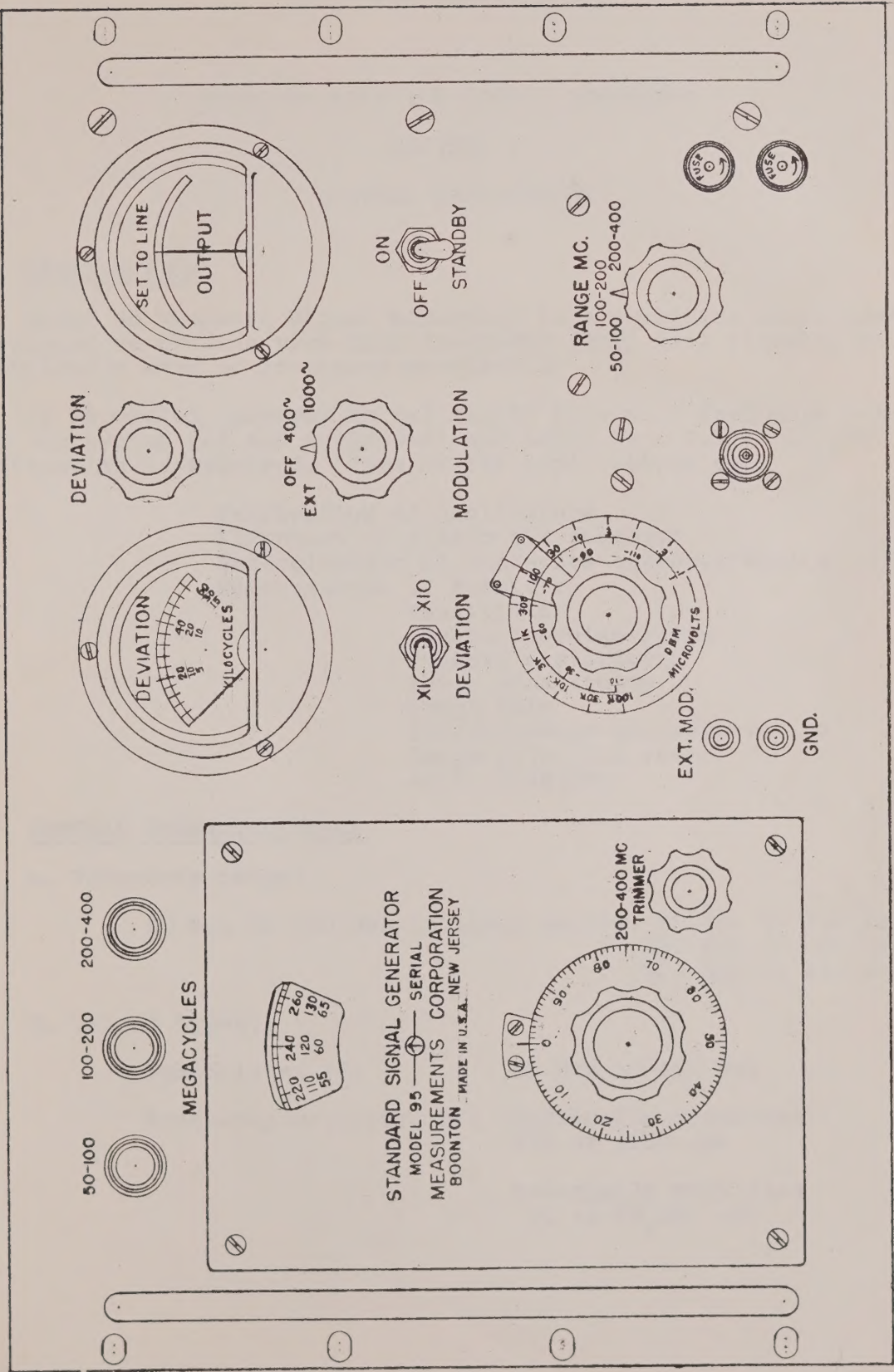


Figure 1.
Model 95 Standard Signal Generator

OPERATING INSTRUCTIONS

MODEL 95 STANDARD SIGNAL GENERATOR

SECTION I

GENERAL DESCRIPTION

1. INTRODUCTION

Model 95 Standard Signal Generator is a precision instrument designed to provide very high frequency (vhf) test signals, either continuous wave or frequency-modulated.

It is useful wherever an r-f signal source of frequency between 50 megacycles and 400 megacycles and level from 0.1 to 100,000 microvolts is required. Some of its applications are:

- Calibration of oscillators
- Alignment of electronic circuits
- Determination of band-pass characteristics
- Measurements of Receiver:
 - Sensitivity
 - Signal-to-noise ratio
 - Overall distortion
 - Power sensitivity
 - Stage gain
 - Discriminator characteristics
 - Image rejection ratio
 - Audio fidelity

2. GENERAL CHARACTERISTICS

a. Frequency range:

50 Mcs to 400 Mcs in three bands-	50 Mcs to 100 Mcs
	100 Mcs to 200 Mcs
	200 Mcs to 400 Mcs

b. Output types:

Unmodulated rf:	50 Mcs to 400 Mcs
Frequency-modulated rf:	Internally modulated 400 or 1000 cps
	Externally modulated 50 to 70,000 cps

c. FM frequency deviation:

In 50 Mcs to 100 Mcs band - 0 to 150 Kcs
In 100 Mcs to 200 Mcs band - 0 to 300 Kcs
In 200 Mcs to 400 Mcs band - 0 to 600 Kcs

d. Input power requirements: 115 volts AC $\pm$ 10%
50 to 60 cycles
125 watts

e. Fuse protection: 2 fuses, type 3AG Slow Blo
1.5 amp

f. Output signal level: .1 to 100,000 microvolts

g. Output voltage accuracy
at 100,000 microvolt level: $\pm$ 10%

h. FM distortion:

Less than 0.5% for 75 Kc deviation on 50-100 Mc band
150 Kc deviation on 100-200 Mc band
300 Kc deviation on 200-400 Mc band

i. Frequency stability after
2-hour warmup: $\pm$.03 percent in half hour

j. Spurious fm below full
rated deviation: 50 db

k. Deviation accuracy: $\pm$ 25%

l. Spurious AM at half
maximum deviation: 15%

m. RF harmonic distortion: 3%

n. RF sub-harmonic distortion: 10%

o. Output impedance: 50 ohms

p. Maximum VSWR of output
impedance: 1.5

q. Frequency calibration
accuracy: $\pm$ 1.0 percent

r. Number of electron tubes: 17



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3. TUBE AND LAMP COMPLEMENT

<u>Schematic Symbol</u>	<u>Type Designation</u>	<u>Function</u>
E1	GE 3S6-120V	Ballast resistor V3 Cathode
E1 spare		Spare
I1	GE #328	Indicates range 50 Mcs to 100 Mcs
I2	GE #328	Indicates range 100 Mcs to 200 Mcs
I3	GE #328	Indicates range 200 Mcs to 400 Mcs
V1	5654	Deviation meter amplifier
V2	5654	Deviation meter diode
V3	5654	AF oscillator
V4	6005	AF oscillator
V5	5654	RF oscillator
V6	5654	First doubler amplifier
V7	5654	RF amplifier
V8	5654	Second doubler
V9	5654	Third doubler
V10	5654	Modulation amplifier
V11	5654	Modulation amplifier
V12	6080WA	Voltage regulator
V13	0A2WA	Voltage regulator
V14	5751	Voltage regulator control
V15	5R4WGA	Rectifier
V16	5654	Surge amplifier
V17	5654	Surge amplifier

4. EQUIPMENT SUPPLIED

The following is included in each shipment, unless otherwise specified on order:

<u>Qty</u>	<u>Description</u>	<u>Weight</u>	<u>Height</u>	<u>Width</u>	<u>Depth</u>
1	Model 95 Standard Signal Generator	70 #	14	21½	15
1	Instruction Book				

5. EQUIPMENT REQUIRED BUT NOT SUPPLIED

RF cable with Type N plug connector on one end, such as MEASUREMENTS CABLE No. 84-Z2-3.

NOTE: It is important that connections between a signal generator and equipment under test be made through suitable cables and pads to ensure matched impedances. A simple discussion and guide, entitled "Signal Generators and the Importance of Matched Impedances", is contained in the article, pages 3-1 and 3-2, which is furnished herewith. The catalog pictures and describes cables and pads as well as other Measurements Corporation equipment now available. Attention is here directed particularly to:

<u>Part No.</u>	<u>Description</u>
80-ZH1	Impedance Matching Pad (50 ohm): 6 db loss, with Type N plug input connector and Type VHF small single contact receptacle output connector.
80-ZH3	Impedance Matching Pad (50 ohm): 6 db loss, with Type N plug input connector and Type N receptacle output connector.
80-ZH4	Carrier Output Cable: 4 ft. coaxial, 50 ohms impedance, Type N plug input connector, 50 ohm termination with binding posts.
84-Z2-3	Carrier Output Cable: 4 ft. coaxial, 50 ohms impedance, Type N plug receptacle each end.

Other pads, not listed, are available in any desirable voltage ratios.

6. ASSOCIATED EQUIPMENT

Model 95 Standard Signal Generator may be used without other equipment (beyond cables and pads) for a variety of tests. However, some tests will require the use of additional instruments. Typical requirements are listed below:

<u>Type of Test</u>	<u>Additional Equipment Required</u>
Alignment (CW signal)	RF or DC vacuum-tube voltmeter or microammeter.
Alignment (FM signal)	Oscilloscope with suitable time base. Audio oscillator.
Bandwidth (CW signal)	Vacuum-tube voltmeter

<u>Type of Test</u>	<u>Additional Equipment Required</u>
Bandwidth (FM signal)	Oscilloscope with suitable time base. Audio Oscillator.
Signal-to-Noise Ratio	Vacuum-tube voltmeter.
Stage gain (CW signal)	RF vacuum-tube voltmeter.
Overall gain	Vacuum-tube voltmeter.
Image rejection Ratio	Vacuum-tube voltmeter.
Audio fidelity	Audio Oscillator. Voltmeter.

SECTION II

OPERATION

1. GENERAL

For accurate, rapid, and easy operation of this Signal Generator the user should familiarize himself with the location, function, and manipulation of all controls and connectors.

<u>Control or Connector</u>	<u>Function and Notes</u>
Power Cord	Provides for conducting 115V $\pm$ 10%, 50-60 cycle, to signal generator.
Power Switch	ON position connects power source for operation of signal generator. OFF position disconnects power. STANDBY position disconnects plate voltage rectifier but leaves filaments energized.
Fuses	Protection in both sides of 115-volt supply ahead of power switch.
RANGE MC Selector Switch	Selects range of output carrier frequency.
MEGACYCLES Indicator Lamps	Indicate position of RANGE MC selector switch and scale to be read on MEGACYCLES dial and on DEVIATION METER: Green for 50-100 range Amber for 100-200 range Blue for 200-400 range
MEGACYCLES Dial	Indicates signal output carrier frequency directly in megacycles. Read scale corresponding in color with lighted indicator lamp.
Tuning Dial	Drives tuning capacitors and MEGACYCLES dial. Drive is disengaged by moving knob toward bottom of panel thus providing for resetting vernier as desired.

Control or
Connector

Function and Notes

DEVIATION meter	Indicates modulation frequency deviation in kilocycles. Read scale corresponding in color with lighted indicator lamp.
DEVIATION switch	Selects range of deviation. Multiply reading of DEVIATION meter by 1 or by 10 corresponding with indicated position of switch.
DEVIATION control	Varies degree of deviation.
MODULATION selector	Four-position switch: 1000 for internal modulation at 1000 cps 400 for internal modulation at 400 cps OFF for unmodulated output EXT for use of external oscillator.
DBM-MICROVOLTS control	Varies output signal voltage level from 0.1 to 100,000 microvolts. Dial face indicates directly dbm and microvolts when: a. Moveable index has been set for calibrated 100,000 microvolt reference level. b. Signal Generator is terminated in a 50-ohm load.
OUTPUT meter	Zero center galvanometer indicates calibrated 100,000 microvolts output reference level. Rotation of MICROVOLTS dial until meter pointer is at zero center, SET TO LINE, indicates that output is 100,000 microvolts. Setting moveable index at LOOK on MICROVOLTS dial when meter is at zero center, makes dial direct reading. (Trimming should be performed in 200-400 Mcs range as noted for 200-400 MC TRIMMER).
200-400 MC TRIMMER	Peaks final doubler stage for maximum output, thus minimizing output distortion. When MICROVOLTS dial control has brought meter to zero center, TRIMMER control should be used to produce maximum output (to the right) on OUTPUT meter. Resetting

Control or
Connector

Function and Notes

of MICROVOLTS dial is then required to obtain direct reading index position.

Output Connector

Type N rf receptacle

2. INSTALLATION AND ADJUSTMENT

Since Model 95 Standard Signal Generator is portable equipment, no permanent installation is required. In use, it should have free air circulation about it. It should not be exposed directly to the weather. No adjustment is necessary prior to operation.

3. PRELIMINARY CHECKS PRIOR TO OPERATION

- a. Connect to 115 volt $\pm 10\%$, 50-60 cycle.
- b. Place power switch to "ON". Allow 5-minute warmup. One of three frequency range indicator lamps should light.
- c. Rotate "RANGE MC" switch. For each position of switch, the corresponding indicator lamp should light.
- d. Set "RANGE MC" switch at 50-100.
- e. Rotate MICROVOLTS dial to obtain center scale reading (SET TO LINE) on OUTPUT meter.
- f. Rotate tuning dial through entire range. Center scale reading on OUTPUT meter should be obtainable at all frequencies by turning MICROVOLTS dial.
- g. Repeat "e" and "f" above with "RANGE MC" switch at 100-200.
- h. Repeat "e" and "f" above with "RANGE MC" switch at 200-400, and TRIMMER at maximum.

4. ADJUSTMENTS FOR UNMODULATED OUTPUT

- a. Determine required test frequency.
- b. Turn power switch to "ON" and allow five-minute warmup.
- c. Set MODULATION selector to "OFF".
- d. Set RANGE MC to required range.

- e. Tune to required frequency.
- f. Make connection from output jack to unit under test.
- g. Rotate MICROVOLTS dial to obtain center scale reading on OUTPUT meter. (For 200-400 Mcs range, set trimmer for maximum output.)
- h. Set moveable index marker to LOOK MICROVOLTS mark. (MICROVOLTS dial will then directly indicate output signal voltage.)
- i. Set MICROVOLTS dial to desired output signal voltage. (Do NOT move index. If index should unintentionally be moved, repeat "g" and "h" above.)

5. ADJUSTMENTS FOR INTERNALLY MODULATED OUTPUT

- a. Determine required test frequency.
- b. Determine required modulation frequency and deviation.
- c. Follow steps "b" through "i" in Paragraph 4.
- d. Set MODULATION selector to 400~ or 1000~, whichever is required.
- e. Set DEVIATION switch and DEVIATION control. The deviation is the reading on the DEVIATION meter multiplied by 1 or by 10 according to the position of the DEVIATION switch. Read the meter scale which corresponds to the carrier frequency range:

0-15 (green) for 50 Mcs to 100 Mcs.
 0-30 (amber) for 100 Mcs to 200 Mcs.
 0-60 (blue) for 200 Mcs to 400 Mcs.

The indicator lamp shows corresponding color.

6. ADJUSTMENTS FOR EXTERNALLY MODULATED OUTPUT

- a. If required modulation is other than 400~ or 1000~, the required modulation frequency may be obtained by using an external audio oscillator.
- b. Connect EXT MOD receptacle to output of the external audio oscillator.
- c. Connect GND terminal on Model 95 to ground terminal of external audio oscillator
- d. Follow steps "b" through "i" of Paragraph 4.
- e. Set MODULATION selector to EXT.
- f. Follow step "e" of preceding Paragraph 5.

SIGNAL GENERATORS AND THE IMPORTANCE OF MATCHED IMPEDANCES

Users of Signal Generators often question the true value of voltage developed across the input of the receiver under test. They are also confused when the apparent sensitivity appears to be a function of the generator with which the measurement is made.

Measurements made with different generators can usually be correlated if consideration is given to: (1) output impedance of the generator, (2) possibility of standing waves on the output cable, (3) effect of load impedance, (4) resonance in leads used to connect generator to load.

The output circuit of the modern signal generator is designed for use with a transmission line output cable. That is, the output terminals, instead of appearing on the front panel, are placed at the extremity of a coaxial cable thereby permitting the use of extremely short leads between generator and load. This cable functions as a transmission line and should be properly terminated at both ends for optimum performance.

Signal Generators are calibrated in terms of voltage appearing across the terminals of the output cable terminated by its characteristic impedance. The following examples will illustrate the errors that may be introduced by line characteristics and load impedances.

RESISTIVE ATTENUATORS

Figure 1 represents the equivalent circuit of a signal generator with step-type resistor attenuator and terminated output cable.

R_O = Terminating resistor equal to characteristic impedance of output cable.

Z_A = Impedance of step attenuator

Z_{SG} = Impedance seen looking into output terminals is referred to as the "output impedance of the generator."

Z_L = External load impedance

E_{SG} = Indicated open circuit voltage across R_O .

E_L = Voltage developed across load impedance.

$$E_L = E_{SG} \frac{Z_L}{Z_{SG} + Z_L}$$

When $Z_L \gg Z_{SG}$, $E_L = E_{SG}$. When Z_L is comparable in magnitude to Z_{SG} , E_L will be less than E_{SG} .

It should be noted that when $Z_A = R_O$ the cable is properly terminated at both ends and the output impedance equals $\frac{R_O}{2}$ and will be substantially constant and independent of frequency. When Z_A does not equal R_O the output impedance will vary with increasing frequency as the cable approaches a quarter wavelength.

MUTUAL INDUCTANCE ATTENUATORS

Let us now consider a mutual inductance attenuator, Figure 2.

E_{SG} = Indicated open-circuit voltage across R_O .

Z_L = External load impedance.

Z_{SG} = Impedance seen looking into output terminals.

R_O = Terminating resistor equal to characteristic impedance of output cable.

At low frequencies the reactance of the coupling coil L is usually negligible and Z_{SG} is very low. As the frequency is increased, however, the reactance of the cable, as viewed from the output terminals increases until the cable becomes a quarter wavelength line and theoretically appears as an open circuit. The output impedance then equals R_O .

SIGNAL GENERATORS

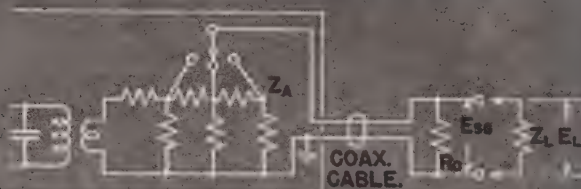


FIGURE 1



FIGURE 2

As in the previous case $E_L = E_{SG} \frac{Z_L}{Z_{SG} + Z_L}$. At the lower frequencies Z_{SG} is very small and for a given value of Z_L loading effect is not as noticeable as at the higher frequencies.

In order to overcome the effect of varying output impedance it is customary to terminate the output cable at both ends. This is accomplished at the generator end by means of an impedance matching pad which isolates the coupling loop from the external cable. The pad is usually designed for a 2:1 voltage loss and the correction indicated by a "pad" fiducial mark on the attenuator dial. The output impedance of the generator is now $R_o/2$ and the voltage across the output terminal is $E_{SG}/2$.

FREQUENCY EFFECTS

As the frequency is increased resonance effects will occur with even the shortest possible leads between the output terminals and Z_L . It then becomes desirable to design the input circuit of the equipment under test to match the characteristic impedance of the cable, thereby eliminating R_o . Whenever the input circuit of the equipment is designed to match a line of different impedance from that supplied with the generator, a suitable pad can be designed to match the generator to the new line.

It is often possible to improvise suitable resistance pads from non-inductive carbon resistors using the shortest possible leads. Simple T pads can be computed from hand book formulas.

They can be calculated on the basis of a simple voltage attenuation ratio such as 2:1 making it convenient to apply a corresponding correction factor to the indicated voltage.

Figure 3 shows an example of a T pad used to match a 50-ohm cable to a 72-ohm receiver.

The resistor values given have been computed to match 50 to 72 ohms with a 2:1 drop in voltage (corresponding to 5.7:1 power ratio).

USE OF DUMMY ANTENNAS

Allowance should be made for the output impedance of the signal generator when testing a receiver through a dummy antenna. Recommended methods for connecting the generator to the receiver are shown in Figure 4.

E_{SG} = Indicated voltage of signal generator

Z_{SG} = Output impedance of signal generator (when properly terminated)

Z_A = Specified antenna impedance.

The output circuit of most signal generators is unbalanced to ground and when the input circuit of the receiver is also unbalanced, the connection shown in Figure 4a is satisfactory. When the receiver input is balanced to ground and the value of $Z_A - Z_{SG}$ is considerably higher than the internal impedance of the generator, the circuit of Figure 4b can be used. The effect of unbalance, usually negligible, may be checked by reversing the connections at the receiver and averaging the two readings.

For measurements at very high frequencies, special transformers for matching unbalanced to balanced lines are available. These are especially recommended for use when testing FM and TV receivers.

For some purposes it is desirable to consider the applied voltage as being supplied by a source impedance Z_o as shown in Figure 5. Then the driving voltage E_o may be considered as equal to twice the indicated voltage, E_{SG} . This concept of driving voltage is convenient when determining the noise factor of receivers. It is also useful for calibrating field strength measuring receivers in terms of the voltage induced in the antenna.

PRECAUTIONS

The signal generator is capable of making accurate measurements when used correctly. A careful analysis of test connections should always be made and the limitations of the generator considered. A pad should be used whenever possible and output cables should always work into a matched load for greatest accuracy of measurement. Where this is not possible, measurement data should be corrected as has been shown above.

Attenuators offer low impedance to power-line voltages. Particular care should be observed when testing AC-DC receivers to isolate test leads with capacitors to avoid damage to the attenuator circuits.

SIGNAL GENERATORS

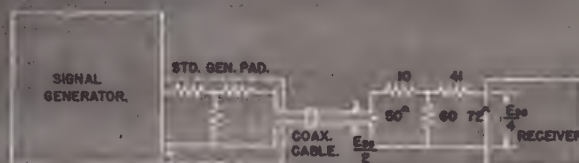


FIGURE 3

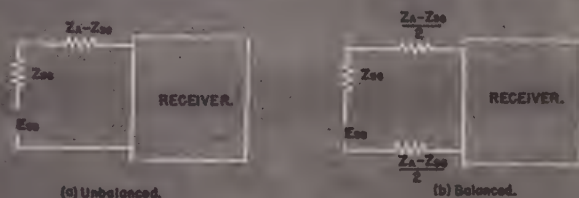


FIGURE 4

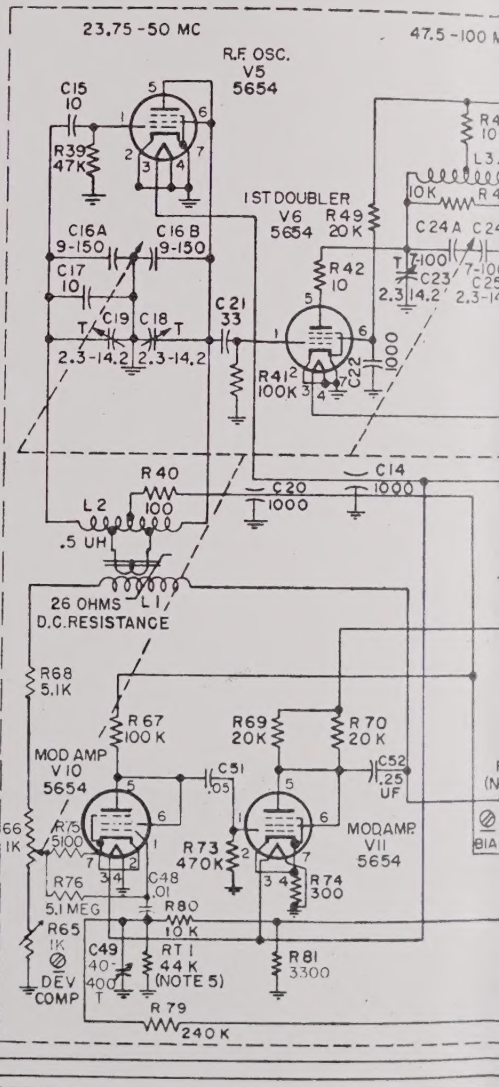
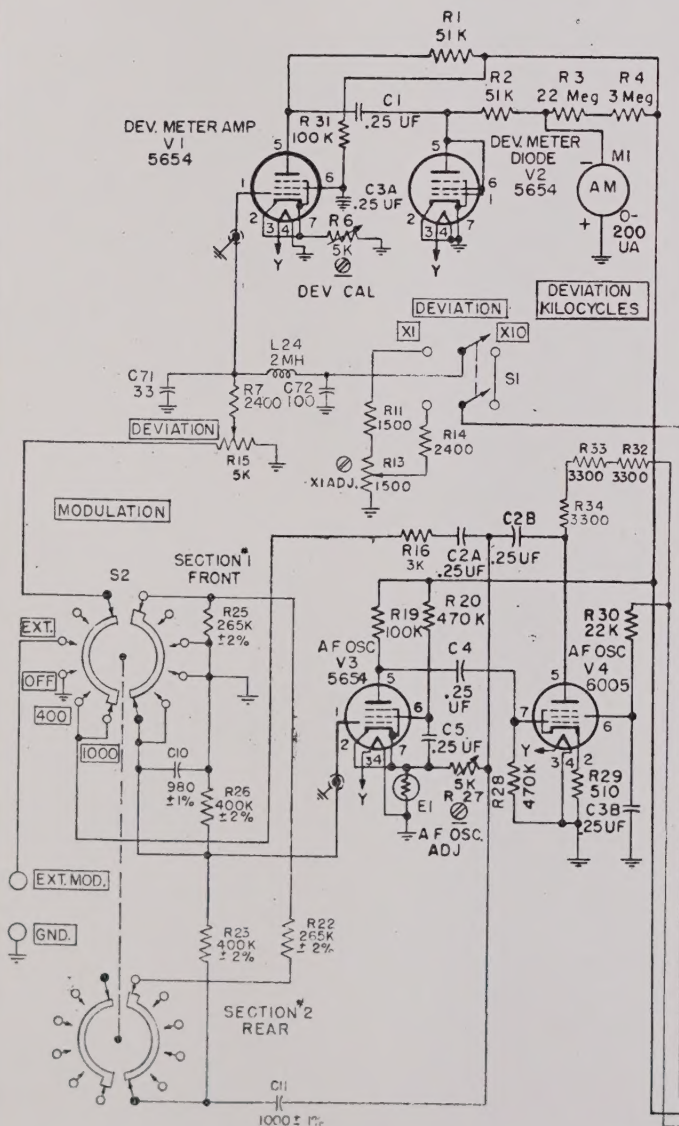


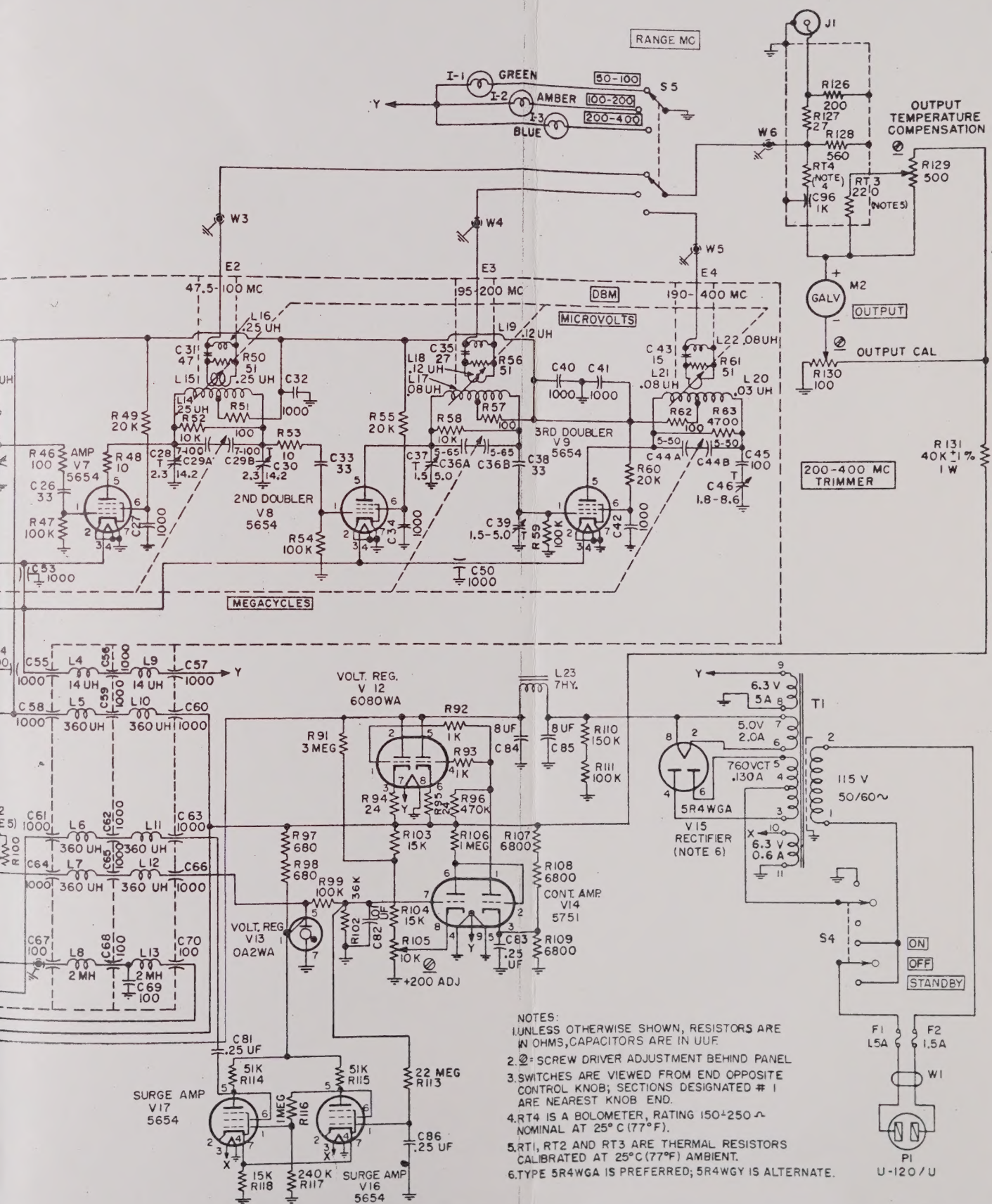
FIGURE 5

MEASUREMENTS MODEL 95 SIGNAL GENERATOR

List of Recommended Maintenance Parts

<u>Schem. Dia. Sym.</u>	<u>Description</u>	<u>Measurements Part No.</u>	<u>Quantity per Instrument</u>
C-18, 19, 23, 25, 28, 30	Capacitor, Trimmer	H-4469	6
C-37, 39	Capacitor	H-4467	2
C-46	Capacitor, Trimmer	H-4468	1
C-49	Capacitor, Trimmer	H-6667	1
I-1, 2, 3	Lamp, Freq. Band	G. E. #328	3
J-1	Connector, Output	H-5655	1
L-1	Reactor	H-4455	1
L-2	Coil	H-4459	1
L-3, 14	Coil	H-4460	2
L-4, 9	Coil	H-4456	2
L-5, 6, 7, 10, 11, 12	Choke	H-4457	6
L-8, 13, 24	Choke	H-4458	3
L-17	Coil	H-4463	1
L-20	Coil	H-4472	1
M-1	Meter, Deviation	H-4436	1
M-2	Meter, Output	H-4437	1
O-3	Index, Output Dial	H-4420	1
RT-1	Resistor, Thermal	H-4465	1
RT-2	Resistor, Thermal	H-5644	1
RT-3	Resistor, Thermal	H-5654	1
RT-4	Bolometer	H-4485	1
S-1	Switch, Deviation	H-6665	1
S-2	Switch, Modulation	H-5671	1
S-4	Switch, "on", "off" "standby"	H-6666	1
S-5	Switch, Band Selection	H-4440	1
T-1	Transformer, Power	H-4464	1
V-1, 2, 3, 5, 6, 7, 8, 9, 10, 11, 16, 17	Tube, Electronic	#5654	12
V-14	Tube, Electronic	#5751	1
V-4	Tube, Electronic	#6005 or 6AQ5W	1
V-12	Tube, Electronic	#6080WA	1
V-15	Tube, Electronic	#5R4WGY or #5R4WGYA	1
V-13	Tube, Electronic Knobs (order by function)	#OA2 or OA2WA	1





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